

# *Bioenergy in Brazil*

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President

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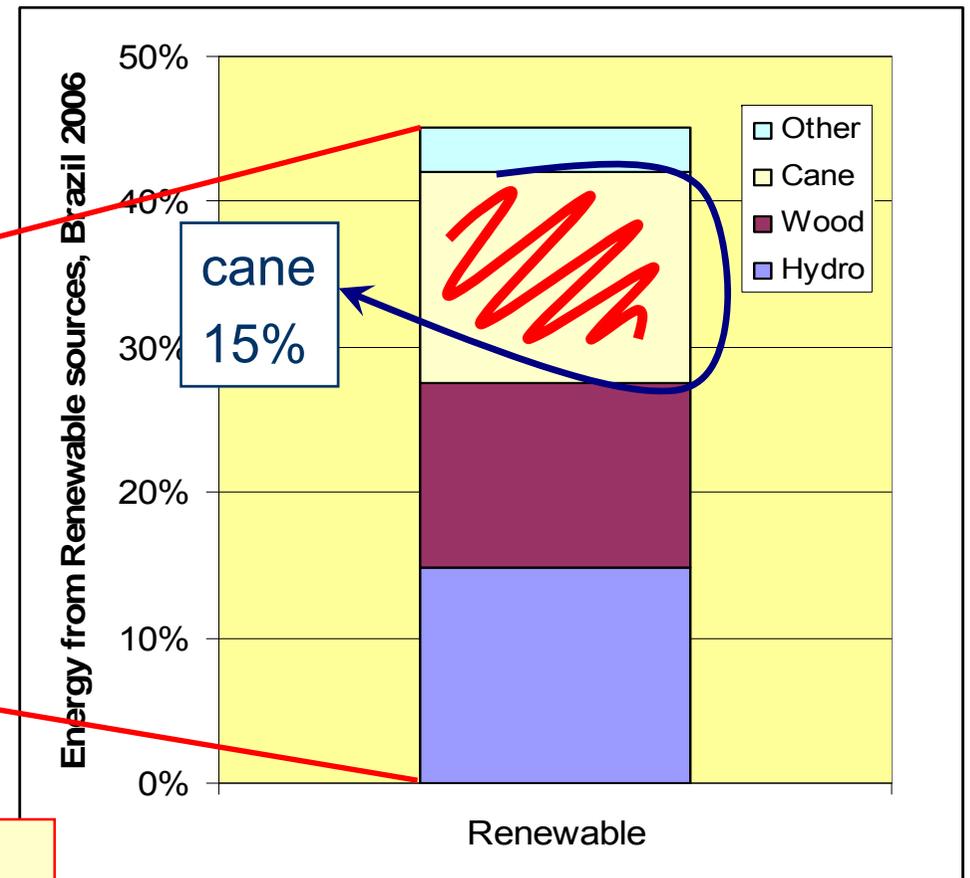
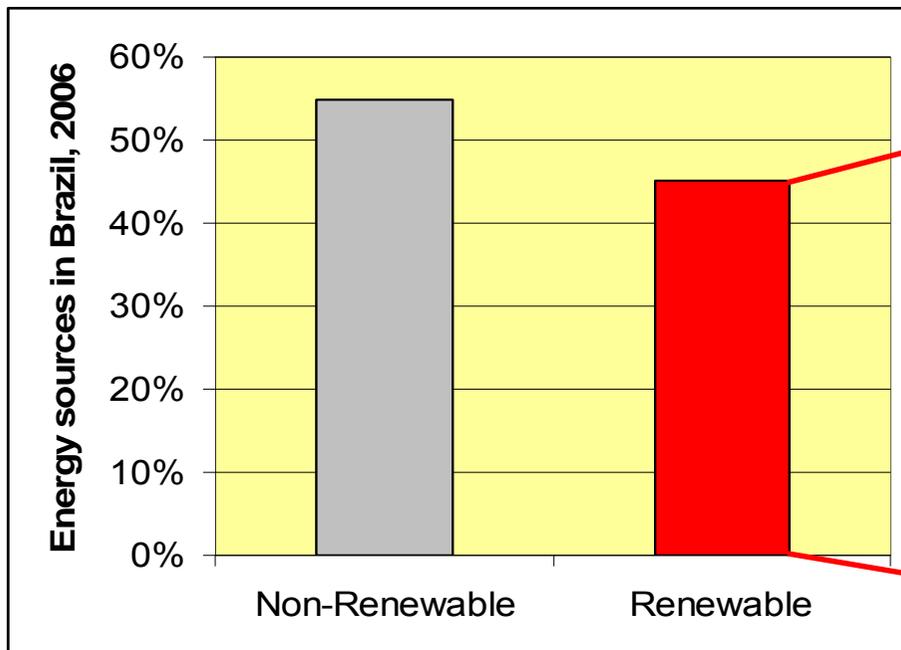
[Presentation prepared by Carlos H Brito Cruz (Scientific Director, FAPESP), with inputs from João Jornada (President, Inmetro) and the Study Group for Biofuels at the Brazilian Academy of Sciences]



# Brazil: 180 million people, 9th GNP



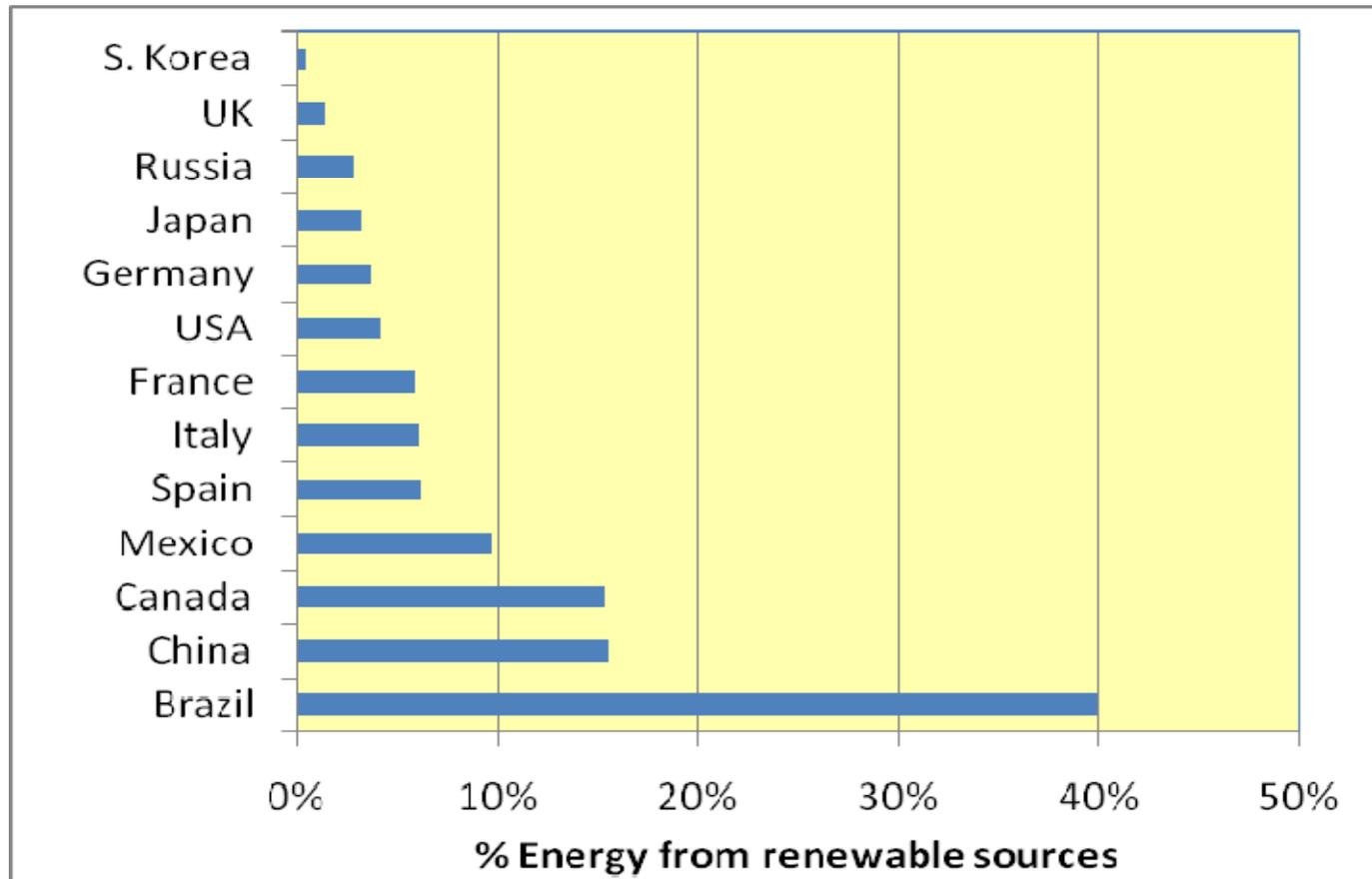
# Energy sources in Brazil



Renewables in Brazil: 46%; World: 13%; OECD: 6%

# *Energy from renewable sources*

## *Some industrialized countries*



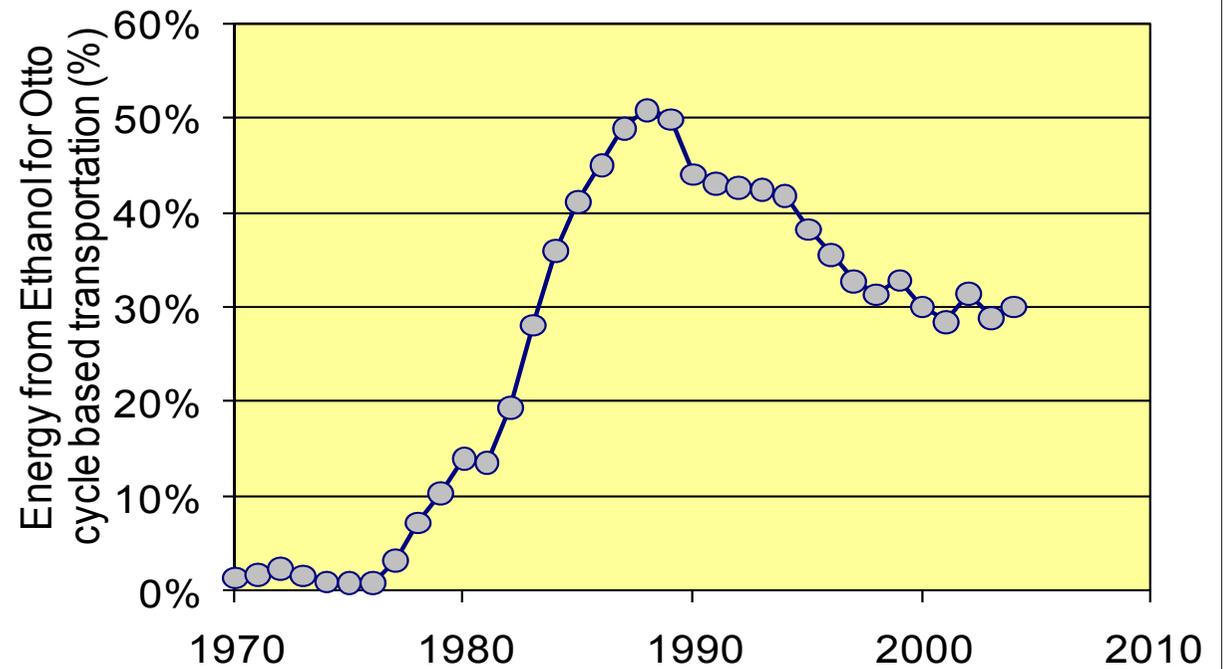
Source: IEA, Renewables Factsheet, 2007

# Ethanol in Brazil

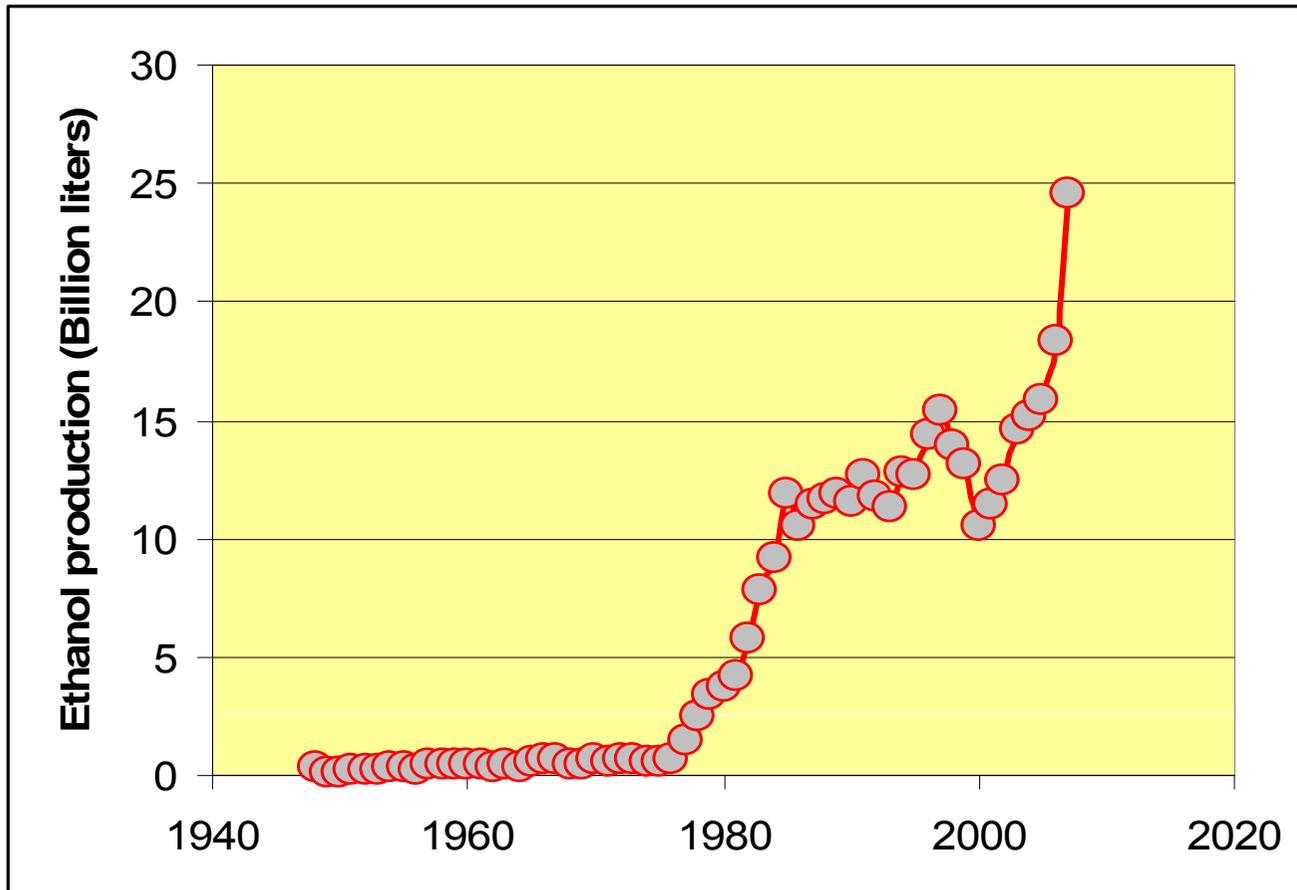


Sugarcane in Brazil: 1532

Mandated addition of Ethanol to fuel: 1929



# Brazil: Ethanol production 1948-2007

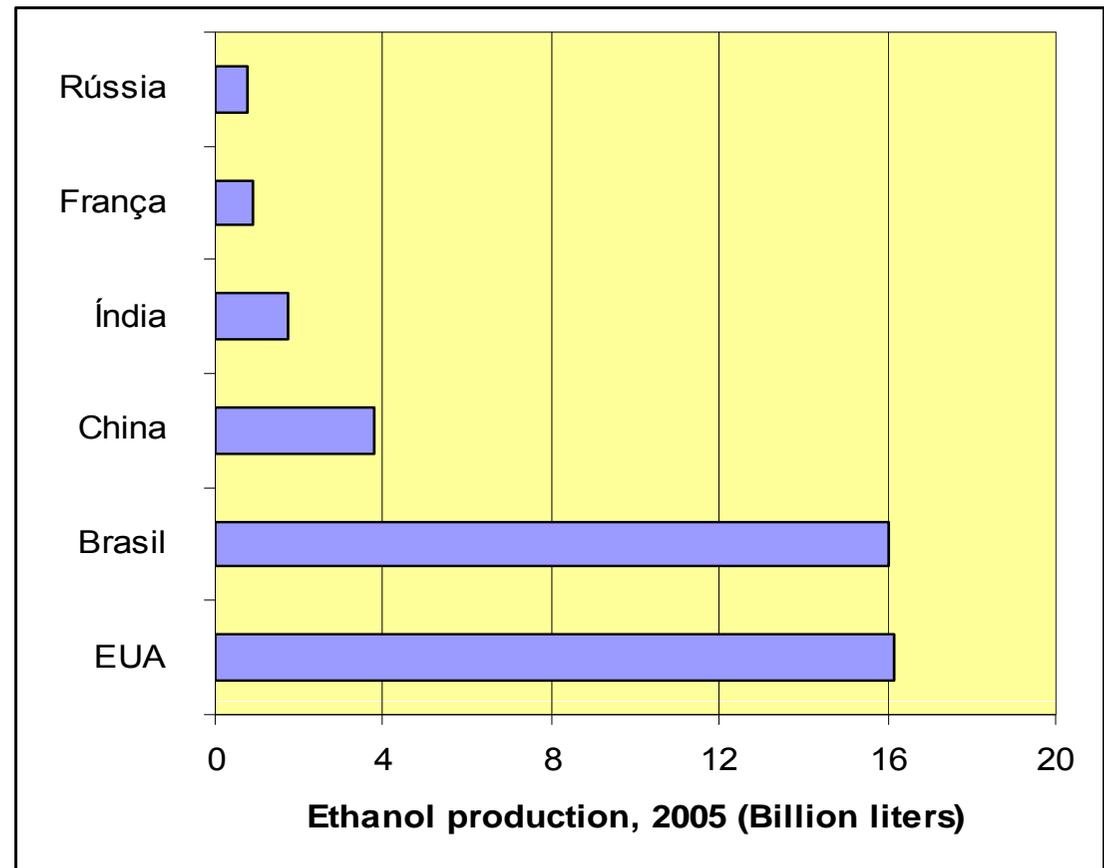


- 1975: Proalcool Program
- 2003: Flex-fuel vehicles
  - 90% of new vehicle sold are Flex
- Gasoline has 25% Ethanol added
  - No pure gasoline in Brazil
- 33,000 gas+ethanol stations (out of 36,000)

Gasoline is the  
**ALTERNATIVE** fuel  
in Brazil

# Ethanol: World Production

- Brazil is 2nd largest producer
- In 2005:
  - Brazil 35% (cane)
  - USA 35% (corn)
- Brazilian production
  - Sucrose: 1/3 of cane
  - Cellulose used for energy

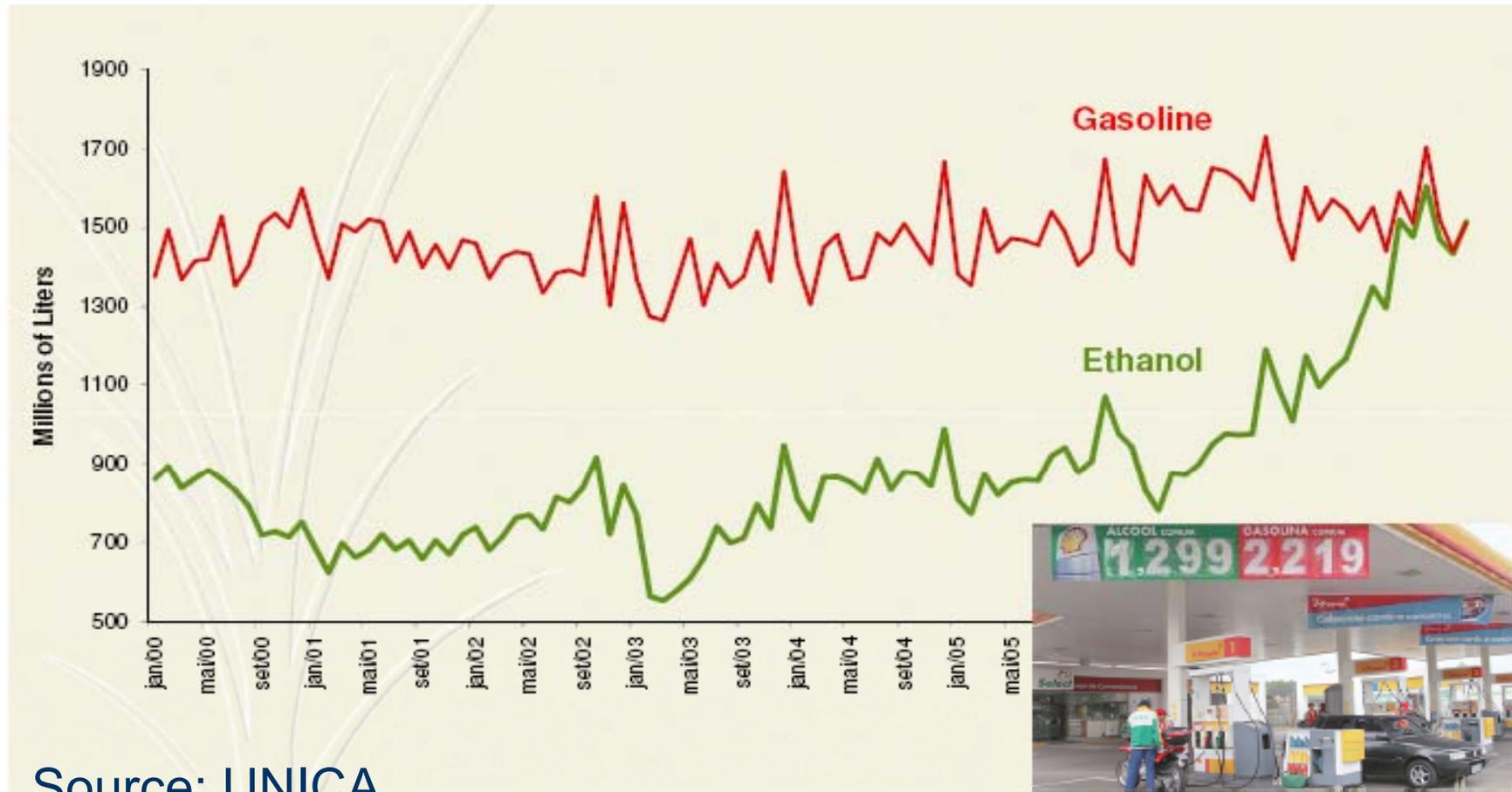


# ***205 GL of Ethanol will substitute for 10% of the world's gasoline***

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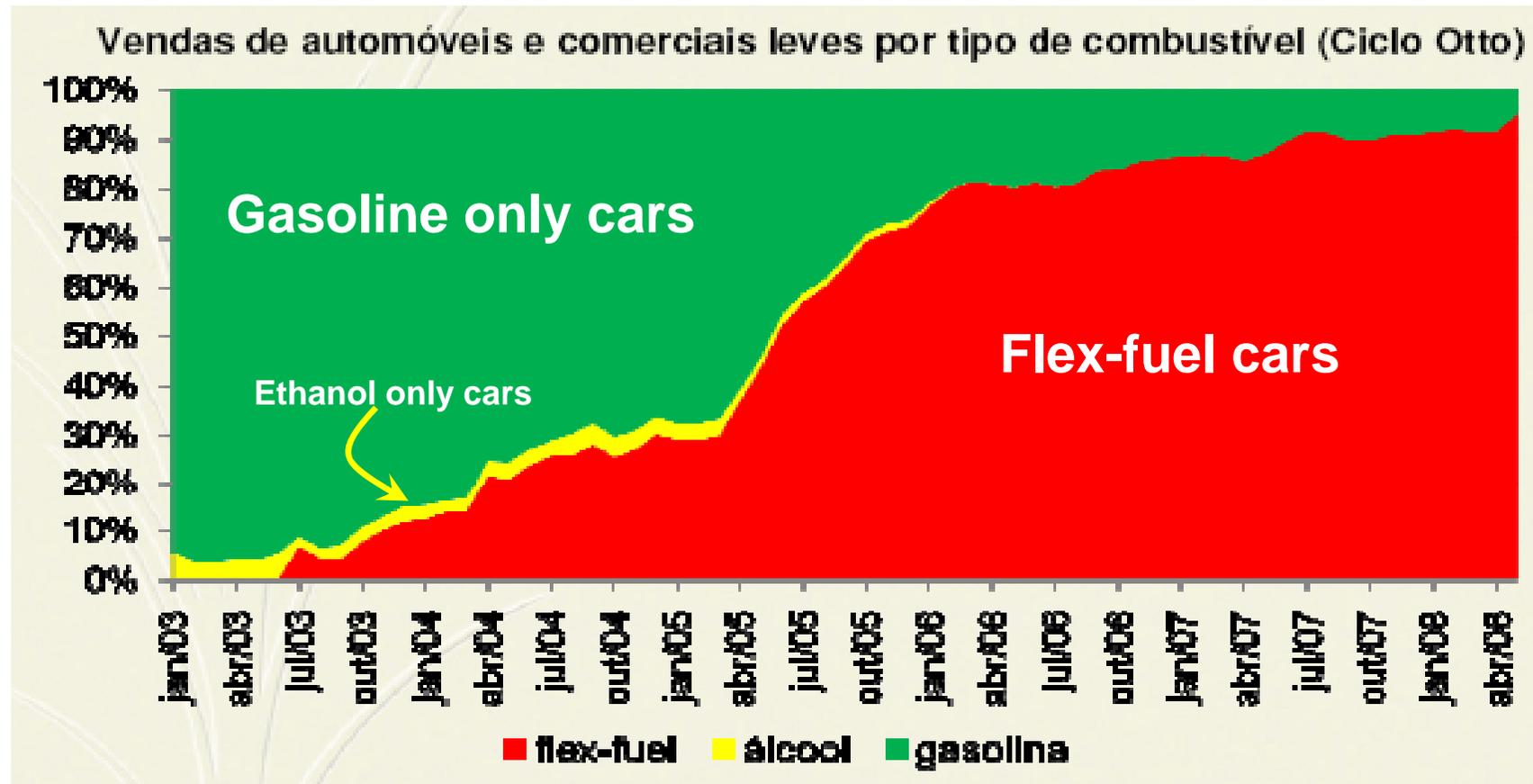
	<b>2004</b>	<b>2025</b>
World gasoline consumption	1,200 GL	1,700 GL
Ethanol consumption	30 GL	
Ethanol substituting 10% gasoline		205 GL

# Brazil: Gasoline and Ethanol consumption



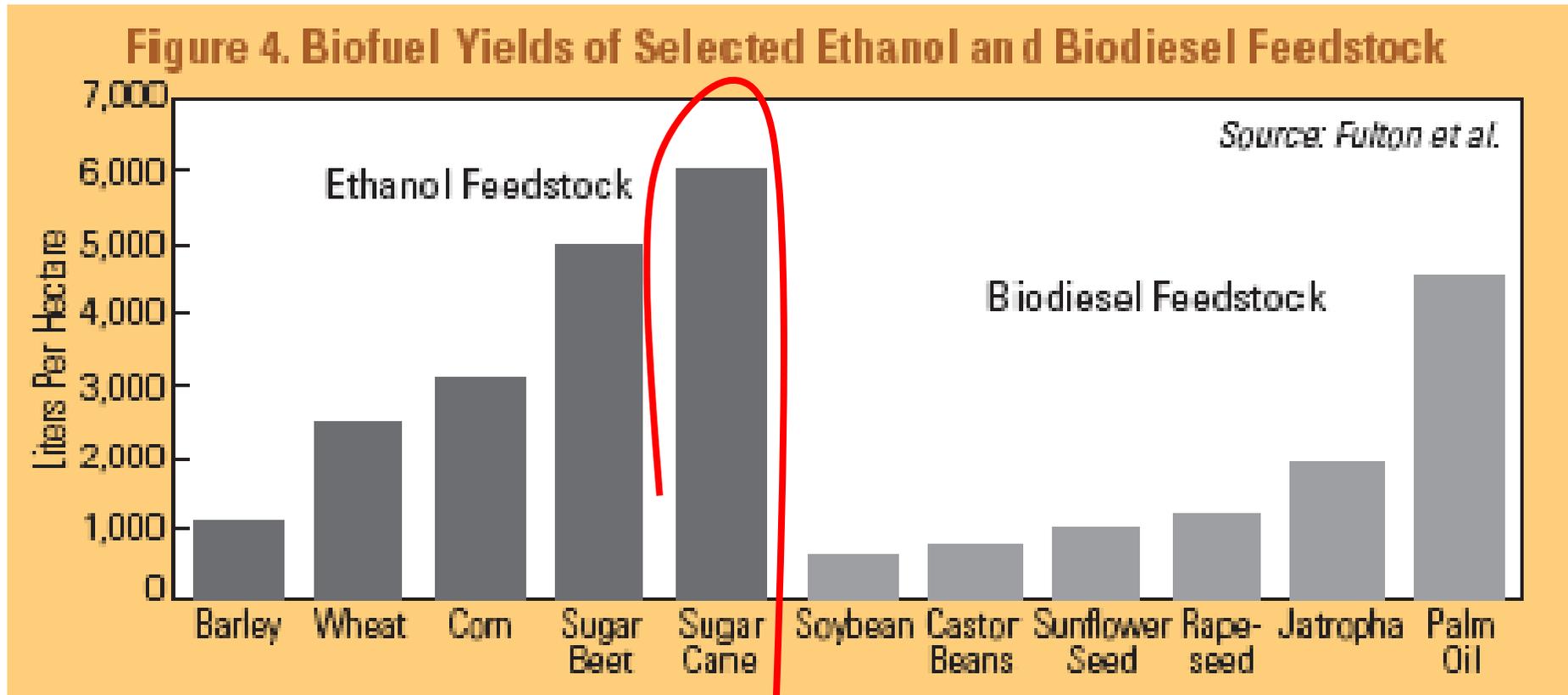
Source: UNICA

# 90% of cars sold are Flex-Fuel



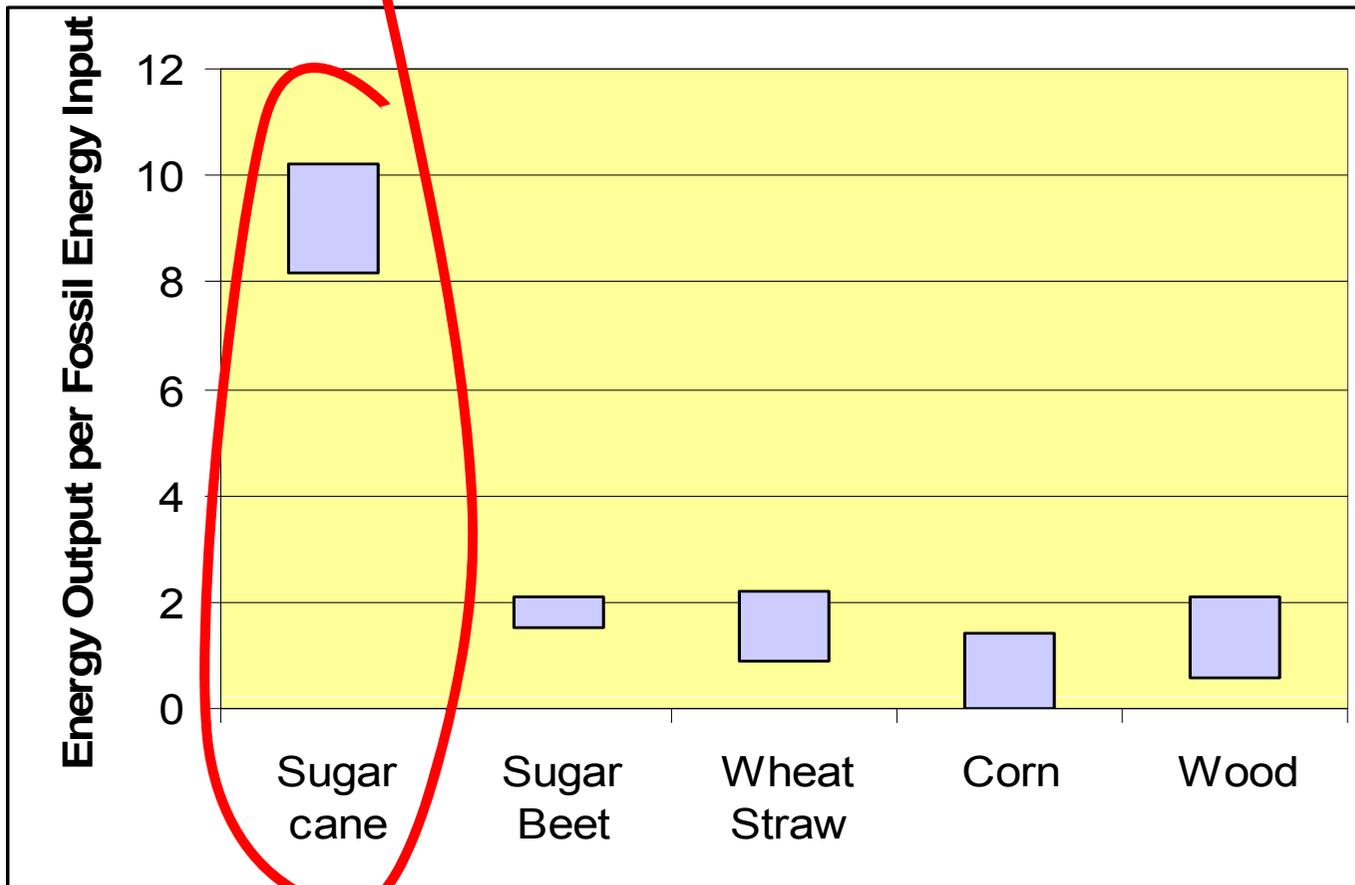
Source: ANFAVEA e UNICA, 2008

# Biofuel yield per hectare

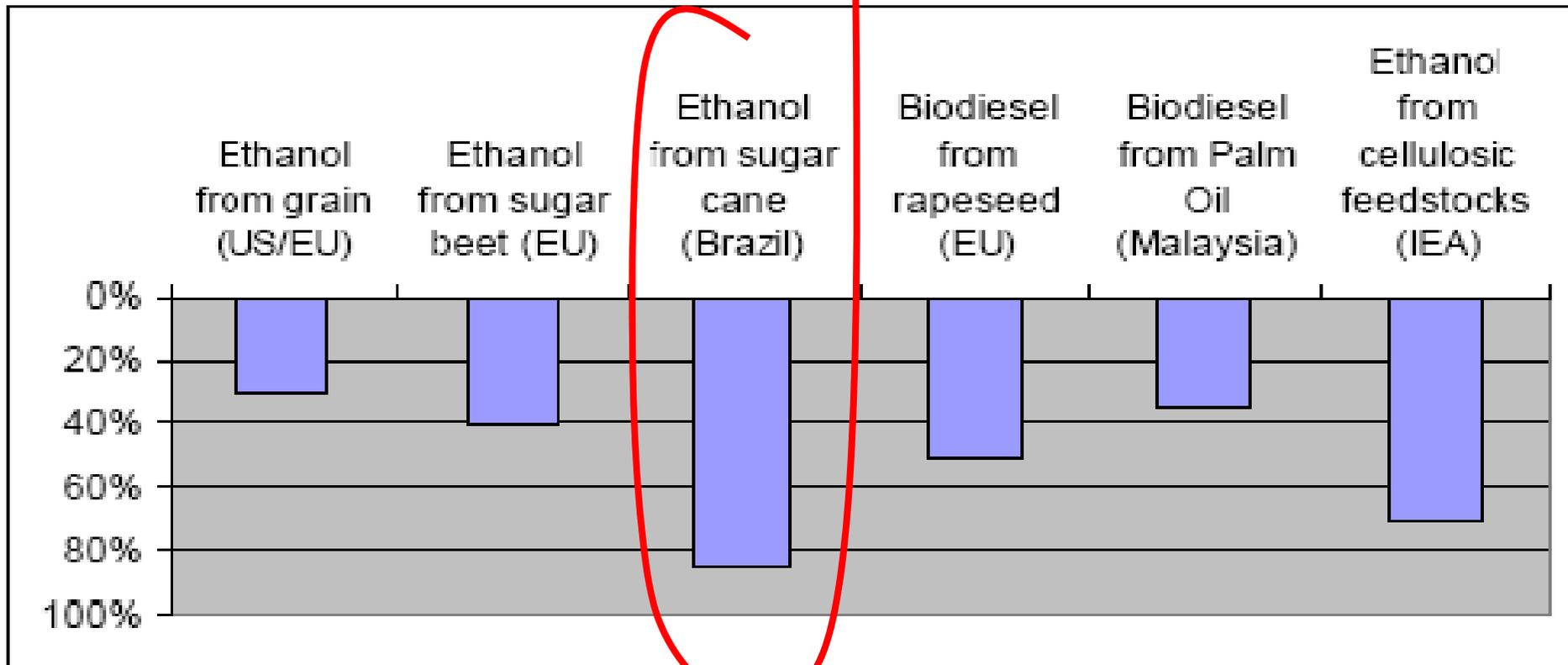


World Watch 2006, [http://www.worldwatch.org/system/files/EBF008\\_1.pdf](http://www.worldwatch.org/system/files/EBF008_1.pdf)

# *Energy balance*

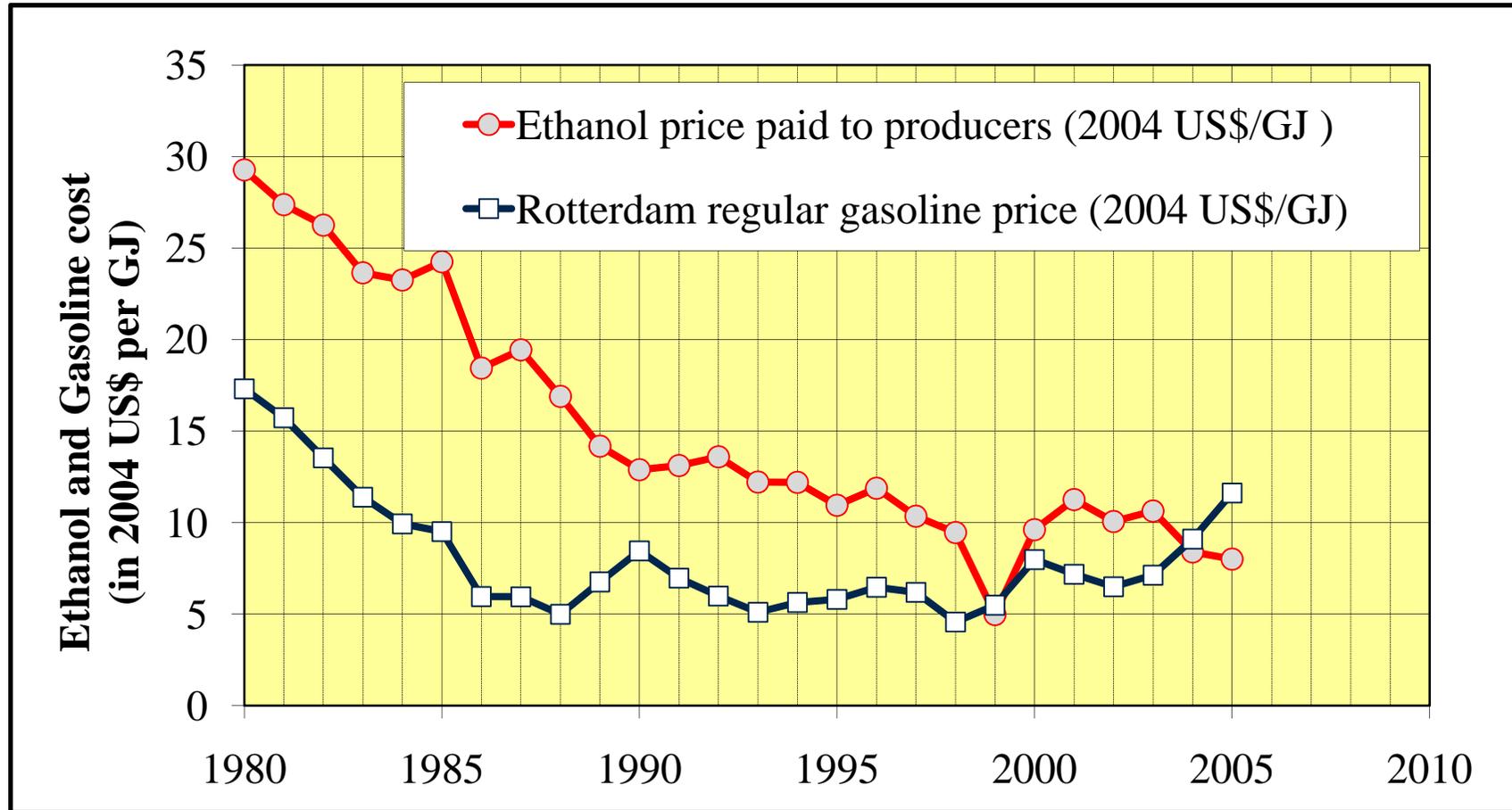


# GHG reduction



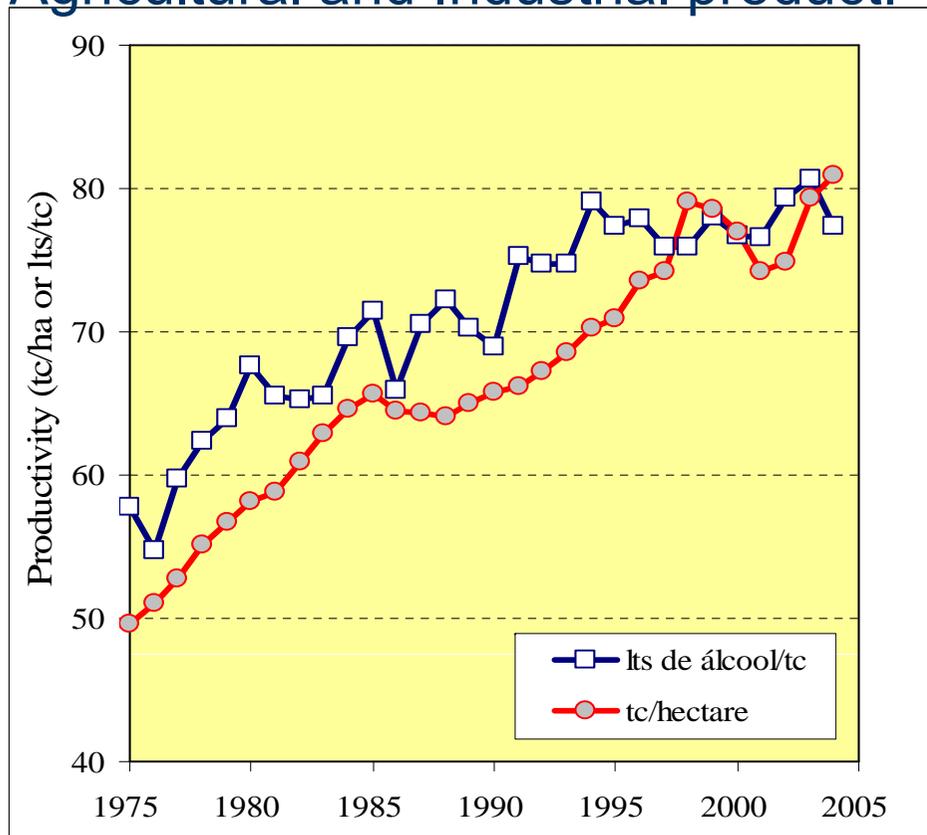
Doornbosch and Steenblik, OECD 2007

# Ethanol costs x Gasoline

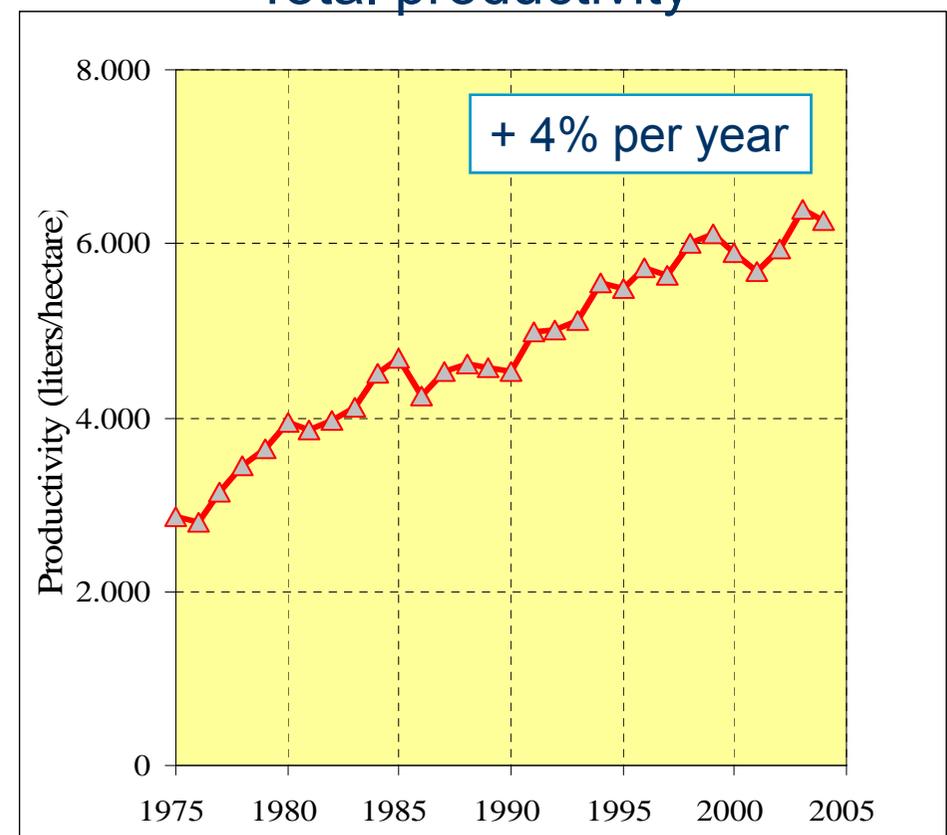


# Increase in productivity through R&D

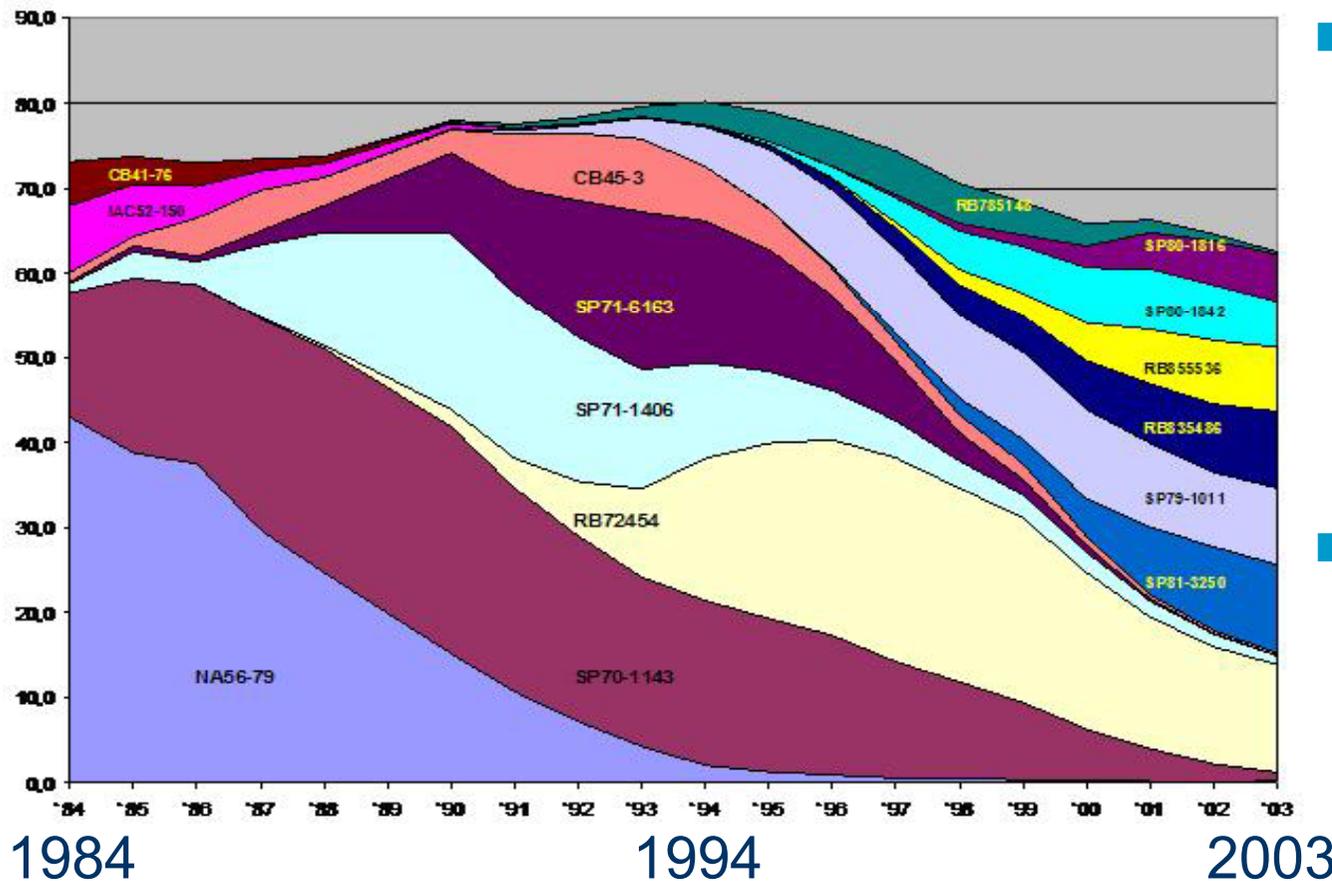
## Agricultural and Industrial product.



## Total productivity



# R&D: Increasing number of Sugarcane varieties used in Brazil



■ Developed by 3 research organizations

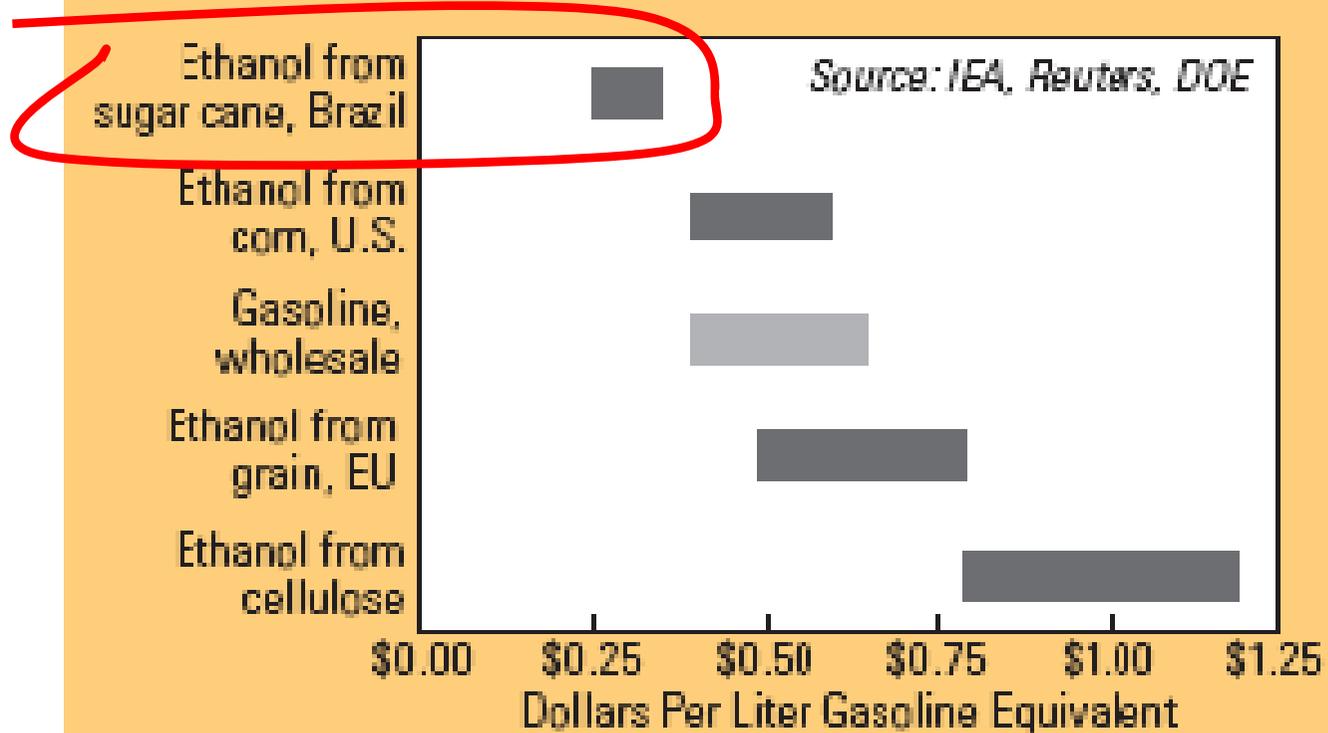
- CTC
- Ridesa
- IAC

■ Plus private companies

- Alellyx
- Canaviallis
- Now Monsanto

# Biofuels costs

Figure 3. Cost Ranges for Ethanol and Gasoline Production, 2006



World Watch 2006, [http://www.worldwatch.org/system/files/EBF008\\_1.pdf](http://www.worldwatch.org/system/files/EBF008_1.pdf)

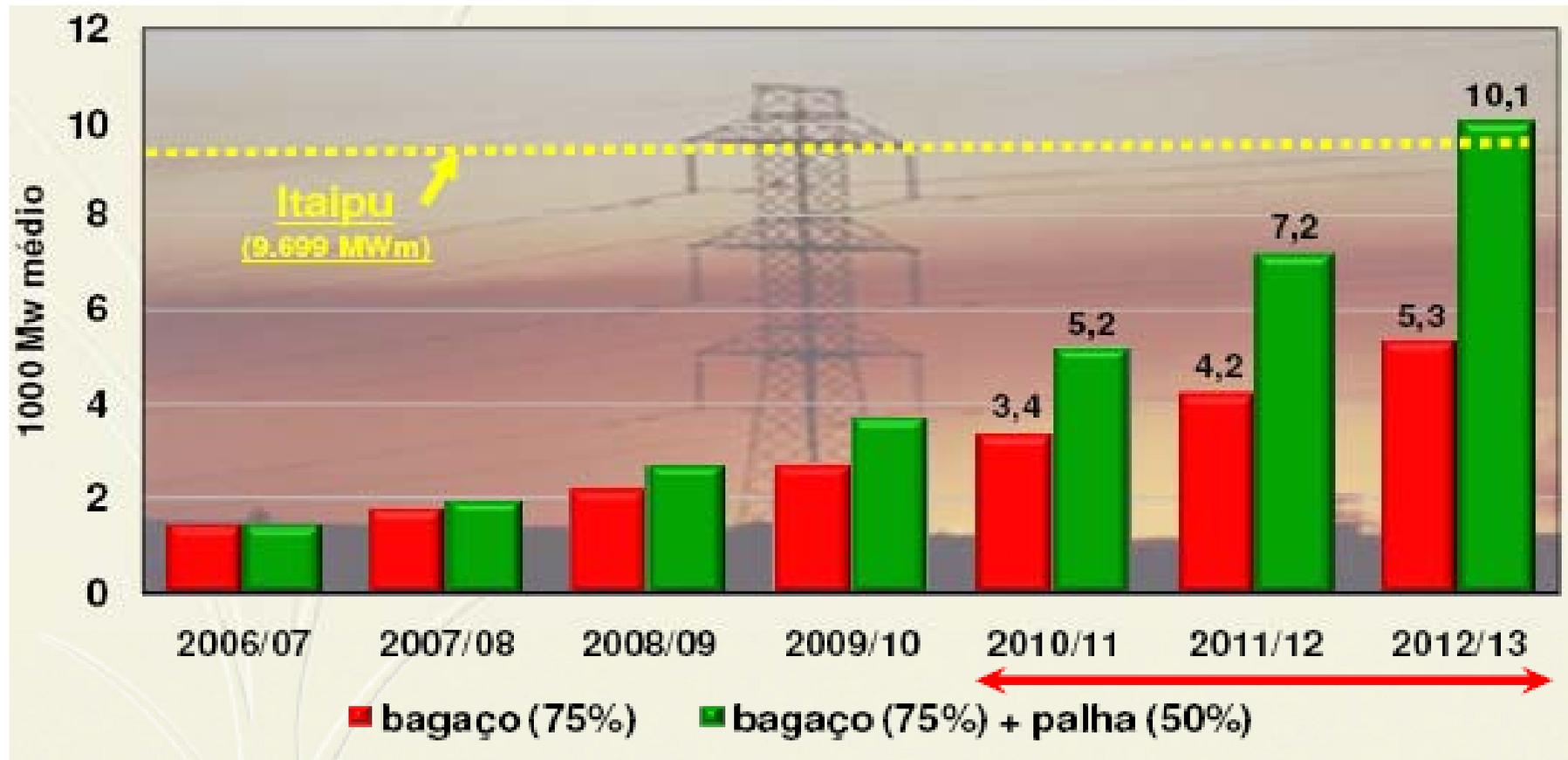
# *Sugarcane energy content*

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- 1 Ton of Cane = 1,2 Barrels of Oil
- Today
  - Sucrose → Ethanol
  - Bagasse → burnt for heat for the mill and electricity
  - Leaves and Stalks → burnt on the field (legislation for phasing out)

# Sugarcane: Ethanol AND Electricity



(Source: UNICA)

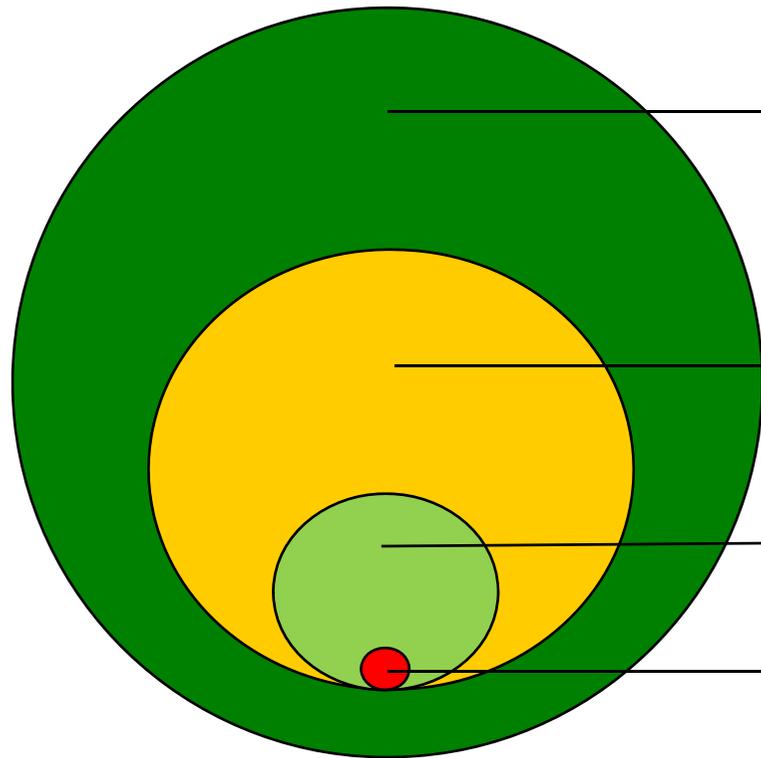
# *Brazil: 1% of arable land displaces 30%+ of the gasoline*

Millions of Hectares (2007)		%	%
		total land	arable land
<b>BRAZIL</b>	851		
<b>TOTAL ARABLE LAND</b>	354.8		
<b>1. Total Crop Land</b>	76.7	9.0%	21.6%
Soybean	20.6	2.4%	5.8%
Corn	14.0	1.6%	3.9%
<b>Sugarcane</b>	7.8	0.9%	2.2%
<b>Sugarcane for ethanol</b>	3.4	0.4%	1.0%
Orange	0.9	0.1%	0.3%
<b>2. Pastures</b>	172.3	20%	49%
<b>3. Available area</b>	105.8	12%	30%
Total arable land – (crop land + pastures)			

Source: UNICA

# *Sugarcane for ethanol uses 0,5% of total area*

Small bioenergy footprint



**Total country area (851 Mha, 100%)**

**Rural properties area (355 Mha, 42%)**

**Area used for agriculture (76,7 Mha, 9%)**

**Area used for sugarcane for ethanol (3,6 Mha, 0,5%)**

Source: Horta Nogueira e Seabra (2008)

# 2050: Available land for biofuels

(Doornbosch and Steenblik, 2007)

Land (in Gha)	North Am.	South & Centr. Am.	Europe & Russia	Africa	Asia	Oceania	World
Total land surface	2,1	2,0	2,3	3,0	3,1	0,9	13,40
1 Apt for Rainfed cultivation	0,4	0,9	0,5	0,9	0,5	0,1	3,30
2 Apt and Under forest	0,1	0,3	0,1	0,1	0,0	0,0	0,80
3 Apt, already in use	0,2	0,1	0,2	0,2	0,6	0,1	1,50
4 Necessary for food, housing and infrastructure until 2030/50	0,0	0,1	0,0	0,1	0,1	0,0	0,30
5 Available (Gross) [5=1-2-3-4]	0,00	0,25	0,08	0,44	-0,07	0,04	0,74
6 % for grassland	0%	0%	50%	60%	n/a	0%	
<b>7 Additional land potentially available (7)=(5)x(1-% for grassland)</b>	<b>0,00</b>	<b>0,25</b>	<b>0,04</b>	<b>0,18</b>	<b>-0,07</b>	<b>0,04</b>	<b>0,44</b>

a. Most studies assume that only a small fraction of additional land is needed to feed the world's growing population — from 6.5 billion people at present to 9 billion people in 2050 — and that most of the increase in food requirements will be met by an increase in agricultural productivity.<sup>6</sup> Here it is assumed that 0.2 Gha is needed for additional food production (based on Fisher and Schratzenholzer, 2001 where a yearly increase in agricultural productivity of 1.1% is assumed); the remainder (roughly 0.1 Gha) is needed for additional housing and infrastructure.

b. A negative number is shown here as more land is cultivated than potentially available for rain-fed cultivation because of irrigation. The negative land available has not been rounded to zero because food imports are likely to be needed from other region with implications on their land use.

c. Numbers in this column don't add up because of rounding.

**0.25GHa @ 10kL/Ha.yr → 2,500GL /yr (in 2005: 40 GL)**

# Reference quantities

Area available in South & Central America by 2050: 0,25 Gha  
Area available in Africa by 2050: 0,18 Gha  
(both according to Doornbosch & Steenblik, OECD, 2007)

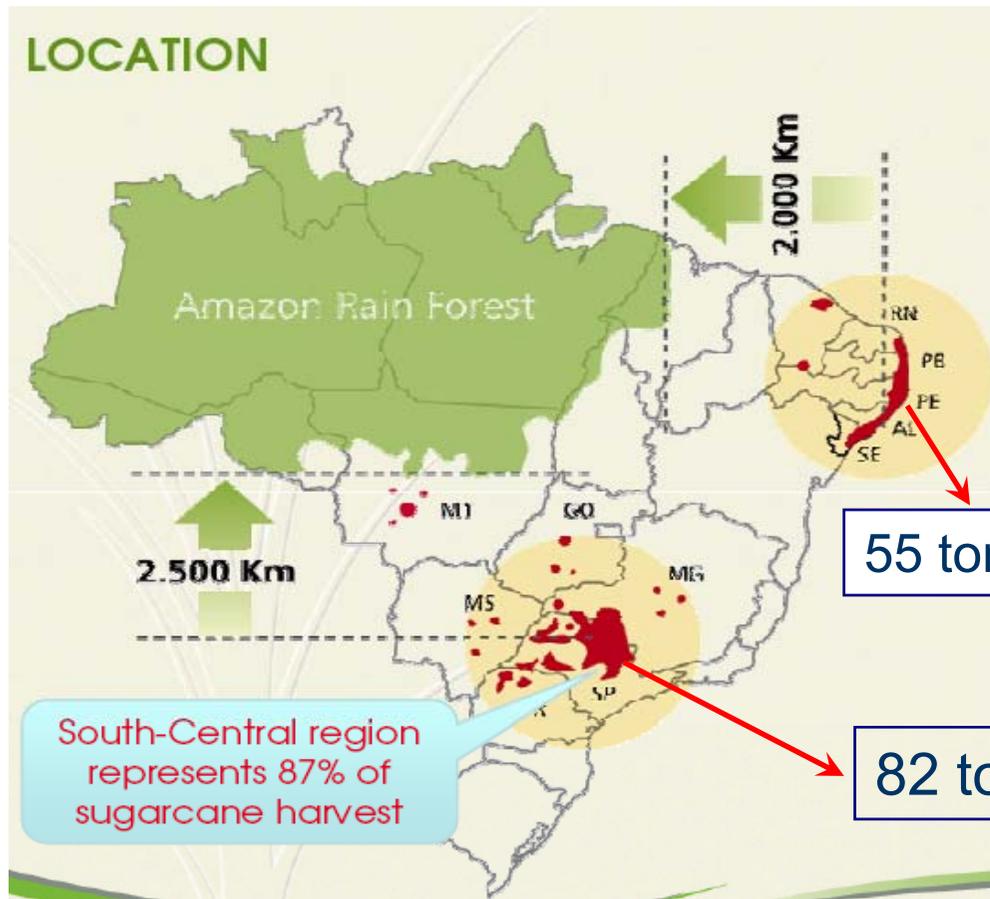
0.25GHa @ 10kL/Ha.yr → 2,500 GL /yr (in 2005: 40 GL)

	2004	2050
World gasoline consumption <sup>(1)</sup>	1,200 GL	2,200 GL
Ethanol consumption	30 GL	
Ethanol substituting 10% gasoline		265 GL
Ethanol substituting 100% gasoline		2,650 GL

(1) Source: *National Energy Information Center (NEIC)*

Potential for substituting for 100% of the world gasoline demand considering only the available area in South and Central America (Africa has another 0,18 Gha)

# Where does Brazil plant Sugarcane?



- Not in the Amazon
- Best land for cane:
  - Northeast coast
    - Oldest (XVI century)
  - Southeast
    - highest productivity
  - Centralwest
    - main expansion area

## Symposium on Biofuels

Measurements and Standards to Facilitate the  
Transition to a Global Commodity

Hosted by:  
the US National Institute of Standards and Technology (NIST)  
and  
Brazil's National Institute of Metrology, Standardization and  
Industrial Quality (INMETRO)



in conjunction with the  
11th Annual Green Chemistry & Engineering Conference:  
*From Small Steps to Giant Leaps – Breakthrough innovations  
for Sustainability*  
Capital Hilton in Washington, DC  
June 26-29, 2007

02042009



# Standards



*Measurement and Standards  
for Biofuels: Enabling a  
Transition from Petroleum as  
a Vehicular Energy Source*



# *High quality measurement standards*



- Inmetro (Brazil) and NIST (EUA) exchange CRMs – Ethanol (Inmetro); Soy Biodiesel (NIST) for validation
- Project BIOREMA – CRMs with UE

# Conclusion

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- Brazil created a large and successful experiment on planting fuel since 1975
- Sugarcane has special characteristics
  - Productivity
  - GHG reduction
  - Favorable energy balance
- Brazilian strategy counts on many other countries producing Ethanol from various sources
  - Technology transfer
  - Cooperative R&D
- Most probable producers: Latin America and Africa
  - Access to energy for developing countries

# *Institutional addresses*

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- The Brazilian Academy of Sciences: <http://www.abc.org.br>
- The São Paulo State Research Foundation, FAPESP: <http://www.fapesp.br/english/>
- FAPESP's Bioenergy Research Program (BIOEN): <http://bioenfapesp.org/>
- Brazilian Institute for Metrology: <http://www.inmetro.gov.br/english/>



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